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SELECTION OF SEED IN POTATO GROWING.

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The crops of Illinois usually rank in value as follows: First, corn; second, hay; third, oats; fourth, wheat; fifth, potatoes. For a number of years potatoes have remained in fifth place, with a total value far exceeding any minor crop. The importance of this crop in Illinois is further shown by the fact that since 1870, there have been about one hundred thousand acres devoted to it annually. This record does not include the amounts grown in the small home gardens, in which the potato invariably finds a place. The average yield per acre has varied from thirty-one bushels in 1890, to one-hundred and twenty-nine bushels in 1889, with a total value of from $2,500,000 to over $6,000,000. The average yield for forty years is eighty-one bushels, and the average annual value of the crop $4,000,000, In 1903, although the average yield in the state was only seventy-seven bushels per acre, which was four bushels below the normal, still, at the ruling price on December 1, 1903, the value of the crop was the highest reached in twenty years. The total yield of the crop was 7,093,132 bushels with a value of $4,985,-

251. *The average value per acre was $53.89, the cost of production $17.00, which leaves a net profit of $36.89 per acre. It reflects small credit upon Illinois that the normal yield should be but eighty-one bushels, when in many localities in other states with soils probably not superior, whole counties raise an average of over 300 bushels, while yields of 400 to 500 bushels per acre on large areas are not uncommon.

It is not the pretense of this circular to be a complete treatise on potato culture, but rather to discuss one point in potato production, upon which it is thought too much stress cannot be laid. This is seed selection. The value of systematic seed selection in the production of corn is now generally acknowledged. The results are so convincing that its worth cannot be doubted, but the fact that this principle may be and should be extended to other crops has not, as yet, been much emphasized.

The Plant.

In its original state, we might consider the potato plant as an annual, reproducing itself each year by means of seeds, with the alternate means of reproducing itself through the small tubers which were grown on its underground stems. However, since the tuber was the part for which it was cultivated, it has been gradually weaned away from its original method of reproduction; and, while the property of reproduction by means of seeds has not yet been lost, it has been greatly weakened through the long generations that have given their life and strength in the production of tubers.

As a rule seed bolls do not form on potatoes grown as far south as Central Illinois, but they usually develop to some extent in more northern latitudes.

Producing New Varieties.

New varieties have generally been produced from seed. Less than one per cent of the varieties annually offered for sale are from "sports," or variation in the hill. Potato plants to be crossed are selected early in the season, and by preventing the formation of large quantities of tubers, are made to give their energies to the production of blossoms. These flowers of the potato plant do not inbreed, that is, they do not fertilize flowers of the same plant, but they do very readily fertilize the flowers of other potato plants. The crossing of the plants desired is accomplished by hand pollination which is carefully done as soon as the pollen is ripe, and the plants are then kept under glass until the seed boll "sets." Only a few bolls are allowed to develop, and from these bolls the seed is planted the next year.

The potatoes produced from this seed average the size of a walnut the first year, although under very favorable conditions, tubers of marketable size are not unusual. Those plants and their progeny which show promise of the continuation of valuable characteristics are propa-

*From the crop reports published by the Secretary of the State Board of Agriculture.

gated the next year, while all others are discarded. By the fourth year, selections may be made for final variety type.

By far the larger part of American varieties have been originated by haphazard methods. Seeds from seed bolls of unknown origin have been planted in large numbers, and the progeny from resulting plants has been selected for a few years for yield, shape, size, and general market appearance. The chief purpose of such growers has been to produce a potato that would supply the demand of the seedsman for something new to advertise in his annual catalog. Other originators of varieties have gone so far as to plant known varieties of marked excellence side by side, and to take seed bolls from them, thereby knowing the origin of the female parent, but still remaining ignorant of the origin of the pollen. These seed bolls are frequently sold as the product of a definite cross between two varieties. There is no doubt that valuable varieties have been obtained through methods such as these, but the chance of success is very slight, and failure may ensue even after the trial of thousands of seedlings.

For the scientific improvement of varieties the experimenter should familiarize himself with all the characteristics of the potatoes with which he is to deal, that they may be so crossed as to neutralize weaknesses and build up the important characteristics of each variety. This method, also will take time, but results are surer in the end.

The Running Out of Varieties.

Professor W. M. Hays of the University of Minnesota says: *"The age to which a variety, propagated by annually planting the root cuttings of a single seminally produced plant, will live before the necessity of renewal by sexual reproduction is resorted to, is not known. But since standard varieties of potatoes remain prominent for only about a third of a century, there is some reason for the belief that the varieties reach their period of old age or senility at that time.

There are no good data upon which to base an estimate of the life of a variety, but allowing that the above statement may be true, this senility will probably have been caused by lack of proper care to keep up the vigor of the stock by rigid selection in the ordinary routine of cultivation. When one takes into consideration the little attention that has been paid to the improving of an originally robust stock, the wonder is that any stock should remain prominent for one-third of a century.

The potato has been forced from its natural functions since the beginning of its cultivation until it expends all of its energy in the production of tubers. This state of artificial development is kept up only by the close selection and watchful care of man, and when there is any cessation of selection for the characteristics required, there is an immediate chance for the plant to turn its power to its natural functions, which have been latent because of the pressure brought to bear upon the pro-

*U. S. Dept. Agr., Div. Veg. Phys. & Path., Bul. No. 29.

duction of tubers. This explains one of the causes of the reversion toward the original wild type of the plant, or the running out of the variety. The potato tuber being a part of the stem of the plant and reproducing each year the characteristics of this plant, it cannot be expected that there will be a marked improvement*in the yearly crop, but it is expected that by not allowing a tuber which shows a tendency to revert in any characteristic to reproduce itself, the variety will be kept up to a high state of vigor and the quality of the tubers maintained.

As we know, the potato is not the heat loving plant that the Indian corn is. It grows with the greatest vitality in the cooler north, and there produces the greatest yield of good tubers with the least amount of care and selection. This is the reason why a great many good potato growers claim that it is more profitable to obtain fresh seed every year from the northern potato districts. There is no doubt that this practice is much better than planting the poorer potatoes from a crop, but even the northern potatoes which are shipped to Illinois for seed are generally only a medium grade of market potatoes which have had no special care in selection.

Long and careful experiments in selection have been made by Burbank of California, Girard of France, Heine of Saxony, and Sutton of England, on the characteristics of the potato, and it has been definitely concluded that the potato tuber by proper treatment can be held normal in vigor and quality. If by proper selection each potato grower may produce his own seed potatoes without going to the expense of importing from the northern states, much greater profit would ensue. Taking as it does from six to thirty bushels of potatoes to plant an acre (depending on distance apart and size of the seed piece), it is no small item to the farmer who has to pay from $1.00 to $1.50 per bushel for his seed.

As to the probable difference in yield between home grown and northern seed, results do not justify the widespread belief that northern seed is the better.

Results at the Illinois Station for the years 1892-3-4, reported in Bulletin No. 40, show that on the average, home grown seed was slightly superior to foreign seed.

Vermont and Maryland experiment stations, working with exchange of seed, and the latter also with Maine grown seed, report conflicting results, but the average is slightly in favor of the home grown seed.

Georgia Experiment Station, in Bulletin No. 8, 1890, says, "Home

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*It has not yet been proved whether a sexual reproduction, as in the raising of potatoes can be used as a basis for actual improvement. Bud variation is in general more narrow then seed variation and some Investigators hold that a part of a plant stem can not transmit better qualities than the whole plant possessed. The best evidence does not support this view. Conditions of growth are more nearly the same for different branches of the same individual than are those of different individuals, but the individuality of different parts of a plant is recognized. Hence, variation will in all probability be less frequent, but nevertheless one tuber may vary to a marked degree from the remaining tubers produced by a potato plant, and may transmit its characteristics.

grown seed gave slightly higher yields than that imported from the north."

Louisiana Experiment Station, Bulletin No. 4 (New Series), 1890, says, "Western grown potatoes are as good for seed as those grown in the east. Home grown seed is as good as, if not superior to, either."

Experiments in Missouri in 1890 with twenty-seven different varieties, show that home grown seed averages slightly better than northern grown seed, in the proportion of 100 to 98.

On the farm of a central Illinois grower, upon the heavy black loam of this section, I have seen one plant of Livingston's Banner, which had been home selected for eleven years, yield fifteen marketable, and five smaller, tubers. One plant of Livingston variety which had been grown from home selected seed for seven years yielded twenty marketable and several smaller tubers, and one plant of a Pink Gem seedling grown from seed three years before, yielded thirty-five tubers, twenty of them already of marketable size on the first of August, and this is one of our latest potatoes. Such results show definitely what can be done by care in this state.

Good Seed.

A successful potato grower in Ohio, writing on the subject says: *"Success in potato growing is dependent largely upon the seed. A large percentage of failures is attributable directly to the character of the seed. Many a farmer says that potatoes cannot be grown profitably on his farm, when the fault lies with the seed he has been using, while the easy trial of good seed is within his reach.

Each grower should obtain a stock of seed for a start from some variety which has shown superior qualities and which has not been allowed to deteriorate in vigor, through neglect. The better way is accurately to test several good varieties upon the farm and determine which produces the best in yield and quality of the tubers. This may be done by measuring out equal sized test plots and weighing and otherwise examining the seed as directed below.

The first stock should have all the care in selection of any of the future seed, and should be purchased from a reliable dealer.

The selection of the variety to be grown should conform to the wishes of the market as regards general type, but beyond this the selection should be made particularly for yield, and the vigor and power of resisting disease which would naturally follow with a high yielder. This selection for yield should also be followed by the selection of individual plants within the variety.

Potato Selection in the Field.

If one finds that one potato plant produces fifteen to twenty perfect tubers, and another under similar conditions produces four or five which are small and imperfect, it makes a great deal of difference

*Agee: Bulletin No. 105, Penn. Dept. Agr.

whether he plants the perfect tubers and has the prolific plant reproduced the next year, or whether the small, defective potatoes are reproduced the next season by the use of such seed.

It has been found that vigor in the mother plant itself is the most important characteristic necessary, in this selection in the field before the vines begin to wither. This may be done by walking through the field and marking plants which show a clear green color, a healthy growth of vine and a stability of stem.

It should be noted that there is a difference between potato plants of healthy and profuse growth which indicates a vigorous individuality, able to produce and support to full size a large yield of tubers; and a dark-green, overgrown plant which indicates that all the strength of the plant has gone to production of vine, and that the tuber formation will be small. At the same time care should be taken to select plants which have shown themselves capable of resisting disease, such as blight, should it attack the field. It is often found that single plants will resist the growth of the blight fungus while all others around it will be stricken. This characteristic is one which may be transmitted to the progeny of the plant, and which may largely increase the value of the next crop.

The actual yields of these individual plants may be obtained when the crop is harvested, and a further selection made. Seed should be taken only from these disease-resisting and best yielding plants, and there is a reasonable assurance that the potatoes grown from a given plant will prove of the same quality and prepotency as the mother plant. Finally having selected the best plants with regard to yield and disease resistance, the selection of individual seed potatoes having characteristics of the perfect type sought, is the thing of primal importance.

The number of points to be noted in selecting individuals is so great that the task of selecting superior potatoes is difficult, the more so because of the fact that really good potatoes are rare. It is all the more necessary, however, that some effort should be made to perpetuate the best possible seed, and the following points are here given, suggesting some evils which should be guarded against.

Type Characteristics.

There are several recognized types of potatoes on the market, but having decided upon the variety, it is easily seen to which type it belongs, and having in mind the perfection of this type, the seed should be selected to conform to this idea as far as possible. Thus, if a round variety is selected all seed should be uniformly of the round type. No seed should be purchased from a dealer that does not show a marked uniformity of type, for a lack of uniformity gives a strong indication that the variety is not fixed, even though it is sold under an old established name.

Size.

In selecting individual tubers for planting the potatoes used should

be fully mature, of moderate size and perfect development; that is, they should be sufficiently developed to give them their full allotment of vigor from the mother plant from which they have been selected. In every healthy plant there are usually a number of mature tubers of nearly the same size, and several which are undeveloped. The undeveloped tubers are immature because, although the plant has had vigor enough to start their growth, they have not been fully developed and matured. The undeveloped tubers do not possess the full vigor of the mother plant. *On the other hand, Girard concluded from his experience that overgrown tubers, or tubers larger than the general size of the variety do not excel the mother plant in vigor, but have merely had more starchy material stored up in them and possess no more prepotency than those potatoes of moderate but complete development. Even if this conclusion should not be supported there is a reason why it is not advisable to grow a variety of tubers larger than is now common. Restaurants and hotels do not wish to buy potatoes so large that they cannot with profit serve a whole tuber with each order, while some lunch rooms prefer to serve two smaller potatoes.

The continued use of small seed gives weaker plants, a diminishing of the size of the total crop and constant increase in the number of small tubers in the crop. This conclusion has been reached by a large number of investigators, both in this country and in Europe, and the discarding of small tubers is regarded as an important point in the production of maximum crops.

Shape.

The shape is one of the special points noted by buyers, and the preference is likely to vary in different localities. Potatoes may be divided into three classes; the round, the kidney-shaped and the oval. The kidney-shaped are probably the most popular at the present time. They look larger, weight for weight, than the other varieties, and, for this reason, sometimes sell better in the markets. The oval potatoes are nearly the same shape, but are thicker through the center cross-section, and taper towards the end. Round varieties are the least popular in most sections, probably because they look smaller in the market, although they hold one point of advantage, in that they sift to a more regular size than do either of the other kinds. †Round potatoes are said to have a tendency to develop discolored hollows on the inside, while some of the longer varieties have the greatest tendency to second growth. Knowing these weaknesses of the different shapes it becomes a matter of selecting a variety as free as possible from these defects of the shape desired by the local market.

Color.

The color of the skin is not a matter of great importance, although it is a fact that sometimes the color of a potato is a prejudice to

*See reference to Girard's work, p. 10.
†Malden: The potato in Field and Garden, p. 107.

its ready selling. The white skinned varieties such as the Rural New Yorker No. 2, or the Carmen No. 3, are in favor at present. Those varieties which show a noticeable network in the skin should have it well marked. The skin should be of moderate thickness, too thick a skin interfering with the cooking qualities and too thin a skin making it a poor keeper. The skin should be clear and smooth and have no tendency to spot, scab or split. The flesh underneath should be a clear white with no hollows, dark rings or discolorations of any kind.

A pure white-fleshed potato should remain white after cooking, both when hot and when cold. A tendency to discolor in this particular is indicative of poor flavor, as well as giving a poor appearance. The potato when boiled should fall to pieces upon pressure, showing a glistening white, dry appearance which indicates that the starch granules have been broken with the heat and the potato thus rendered digestible.

Depth and Number of Eyes.

*To be of value in cooking where the potato is peeled before boiling the eyes should not be too deep, as this gives an opportunity for great waste in the peeling. A very shallow eye shows a lack of vitality of the tuber, but while the vitality usually increases with the depth of the eyes, when set too deep it indicates coarseness of flesh and flavor.

Tendency to Second Growth.

Second growth nearly always indicates that the tuber has been checked or stunted at some period of its growth, and that it has not had the strength to recover and keep on its natural development, but had developed in a way easiest for the plant when growth was again started. This decadence will be greatly checked by methodical selection, but if the tendency persists, there should be a change of seed to that of a stronger, fresher variety.

Keeping Quality.

Last, but not of less consequence, is the keeping quality. This is especially important in the southern part of the state. A good keeping quality is very marked in some varieties that have been especially selected for this property. This attribute will naturally be strengthened if care is taken every season not to plant those potatoes which are badly sprouted or have begun to rot. It is merely a business proposition in this as in other cases because the crop from these potatoes will be small and weak, and the same amount of ground will have been used as if good, well kept seed had been planted.

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*The investigatiens of Professer Snyder, reported in Bulletin 43. Office of Experiment Stations, U. S. D. A., have shown that there is great waste in peeling potatoes before boiling. He summarizes as follows:

1. In order to obtain the highest food value potatoes should not be peeled before cooking.
2. When the potatoes are peeled before cooking the least loss is sustained by putting them directly into hot water and boiling as rapidly as possible. Even then the loss is considerable.
3. If potatoes are peeled and soaked in cold water before boiling the loss of nutrients is very great; being one-fourth of all the albuminoid matter. In a bushel of potatoes the loss would be equivalent to a pound of sirloin steak.

THE INVESTIGATIONS OF PROFESSOR AIME GIRARD.

Even in warm climates, as in France, systematic selection of home grown seed has given such excellent results that the increase of trouble has been well repaid, and the system merits a trial by all Illinois growers.

It is interesting to note the conclusion drawn by Professor Girard* of France, who has probably done more scientific work upon potato culture than any other man. His experiments extend over a period of eleven years touching almost every question regarding the growth and culture of the plant. The primary object of the investigations was to see if it was possible to make the soil of France, which produced an average of 7,355 kg. per hectare in 1889, produce crops equal to the best German land, which is perhaps Saxony, where 26,000 to 32,000 kg. per hectare is a common harvest. (Kilograms per hectare are nearly the same as pounds per acre). He succeeded beyond his hopes in working out rules of culture by his experimental plots, and, by use of his rules, farmers working under his direction in different parts of France obtained crops several times as large as the average crop of France. Numerous yields of 600 bushels per acre were obtained over large fields while all cultivators departing from the method given, obtained far smaller yields. The highest record was reached in 1891 when one man, on a plot containing about fifty square yards harvested at the rate of 1,353 bushels per acre.

From the reports of most trustworthy cooperators with Professor Girard in 1892, 231 out of a total of over 600, over half had followed the entire directions and had obtained crops of 450 bushels or more per acre, in spite of a prolonged drought during the year. Professor Girard's investigations included among others the following important points:

A physiological study of the tubers, leaves, stems and roots at all stages of growth; the composition of these different parts during the life of the plant; the climatic conditions during the various seasons, and the best methods of culture; these methods being first worked out under his personal supervision and then extended to cooperators in all parts of France.

The main points emphasized in the rules for culture which Professor Girard has worked out and used with such success are, in brief, as follows: Planting should be done as soon as it is practiable after the danger of hard frost is past. The poorer ground should be heavily fertilized (he used 950 pounds mixed fertilizers per acre on poor land) using decreasing amounts on better land. The seed bed should be prepared to sixteen inches in depth, the ground kept well worked during the season, and care taken to keep the growing potatoes covered. Whole, medium sized tubers were planted 19 inches in the row, in rows 24 inches apart;

*Investigations on Potato Culture. (Recherches sur la culture de la Pomme de Terre) Published by Ganthier-Villars et Fils. Paris. 1891.
Also: Ann. Sci. Agron., 1892. I. No. 2. pp. 250-295. Abs. in Exp. Sta. Record. Vol. 5. pp. 117-120.

great stress being laid on the fact that when in full growth the plants should touch each other. Bordeaux mixture was used as a preventive of blight and the crop allowed to grow until every portion of the vine was dead.

The selection of potatoes for planting was made from the best yielding plants which had been marked in the field for their healthy, luxuriant foliage.

Regarding degeneration or running out of varieties from using the same seed year after year, Professor Girard says:

"It is an opinion quite broadly held that varieties of potatoes cultivated continually in the same region, are certain to degenerate. It is a frequent thing to hear large potato buyers or starch manufacturers declare that after having imported and placed at the disposition of their growers varieties of potatoes noted for their large crops, they have seen them give excellent results the first year, fall away in the second year and give results even lower than the native potato in the third year. This is indeed true, but it is by no means inexplicable; the degeneration which one sees in this circumance, does not result from a natural weakening of the variety; *it simply results from the entire lack of care with which the plants to be perpetuated are chosen.* All the good tubers are sold to the markets, and it is from the inferior, discarded tubers that has been demanded a continuation of qualities which they cannot give.

"I have demonstrated practically, and have established the fact that if suitable tubers are selected for planting, and the cultivation accomplished with the needed care, the quality and quantity of the crop will be maintained under all satisfactory climatic conditions."

It should be explained that the conclusion reached by Professor Girard, as set forth in the last sentence quoted, was obtained as the result of eleven years' investigation on potato growing. How much longer the quantity and quality of his crop could be obtained by the above methods is unknown and can only be determined by longer experiment; but from the fact that no signs of degeneracy from the continued use of selected seed were seen at the end of his investigations, it is reasonable to conclude that these potatoes would not have weakened in vigor for some years to come at least.

Numerous characteristics, indicative of good quality in potato tubers have been discovered since the publication of his investigations, and with due care in all these points, results of sufficiently lasting value may undoubtedly be obtained.

References.

For methods of culture and other facts of great interest to potato growers, the following bulletins may be obtained free by applying to the Secretary of Agriculture, Washington, D. C.: Farmers' Bulletin No. 35, "Potato Culture;" Farmers' Bulletin No. 91, "Potato Diseases and Treatment."

The following are names of dealers in seed potatoes, and there are undoubtedly many others:

L. L. Olds Seed Co., Clinton, Wis.
W. H. Maule, Philadelphia, Pa.
Northrup, King & Co., Minneapolis, Minn.
Vaughan's Seed Store, Chicago, Ill.
W. A. Burpee & Co., Philadelphia, Pa.
J. M. Thornburn & Co., New York, N. Y.